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PTERIDOPHYTIC FLORA OF SIMLA HILLS (NORTH WESTERN HIMALAYAS) FAMILY: ATHYRIACEAE

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ABSTRACT

The paper deals with the taxonomic account of family Athyriaceae from Simla hills. Twenty one species are described and illustrated. The members of *Athyrium nigripes* group (*A. nigripes*, *A. clarkei* and *A. setiferum*) are characterised by the presence of setae on upper surface along costae and costules and possess non-perisporiate spores. The western Himalayan samples of *Cystopteris fragilis* possess rugose-verrucose spores in strong contrast to the spiny spores in several European examples. *Athyrium mackinnoni* is very distinct from *A. nigripes* under which its specimens have often been described. The Simla samples of *Athyrium fimbriatum*, in comparison to those from Darjeeling-Sikkim area, are of much smaller size and less divided. *Diplazium polypodioides* of the area is a polymorphic species and the different forms can hardly be taxonomically separated.

INTRODUCTION

The family Athyriaceae was construed by Alston (1956) to separate those fern genera which were previously included under family Aspleniaceae (under tribe or group Athyrieae) but differ markedly from *Asplenium* and its allies in stipe and scale structure, supply to sorus, chromosome number, and structure of rhizome meristele. Taxonomy of the Himalayan members of *Athyrium* Roth, the type genus of the family and *Diplazium* Swartz, often merged with *Athyrium* by several authors, is very little understood. Descriptions of the majority of the species (some of these endemic to the Himalayas) of these two genera included in this paper are not available in any of the works on the Indian ferns. Several of these species were previously listed by Clarke (1880) and Beddome (1883) as a variety or a form of other species. The present account dealing with members of the family Athyriaceae forms a part of the senior author's work on Pteridophytic flora of Simla Hills in the North Western Himalayas.

ATHYRIACEAE

Members invariably terrestrial; rhizome ascending or creeping; scales pale to dark-brown, non-clathrate; stipes weak or stout, usually with two strap-shaped vascular bundles uniting upwards into single U- or V-shaped one, naked or paleaceous at base or throughout, sometimes hairy, often the adaxial groove present; lamina of variable size and shape, simply to decompoundly pinnate, membranaceous to coriaceous in texture, glabrous or pubescent or hairy; veins free, single or forked, ascending; sori superficial (sporangia always on receptacle and with stalks consisting of 3 rows of cells), usually elongated, oblong or rarely rounded (*Cystopteris, Dryoathyrium*), often on acroscopic side of veinlet, in some on both sides, always indusiate; indusium membranaceous, fugacious at an early stage in many, single or double and not fused (*Diplazium*) or fused at anterior end like a hook or horse-shoe shaped or orbicular and attached by a deep sinus (*Athyrium*) or ovate-acuminate with inferior base (*Cystopteris*); spores bilateral, monolete, with or without a perispore.

KEY TO GENERA

A. Sori rounded
  B. Indusium ovate, attached to the base of the receptacle on basiscopic side only ... ... *Cystopteris*
  B. Indusium reniform, or athyrioid, lax, multicellular hairs present ... *Dryoathyrium*
A. Sori not rounded
  B. Sori always on acroscopic side, linear-oblong, short, hooked at anterior end, hippocrepiform, J-shaped or horse-shoe shaped; indusium prominent and attached by a sinus ... ... *Athyrium*
  B. Sori linear-elongated, never curved, on acro- or basiscopic or both sides, rarely short, indusium elongated, often double and back to back ... ... *Diplazium*

Out of 21 species described, as many as six species, namely, *Athyrium rupicola, A. mackinnoni, A. foliolosum, A. dentigerum, Diplazium lobulosum* and *D. spectabile* are endemic to the Himalayas.

Some members of *Athyrium* and *Diplazium* are large-sized and prominent, flourshing often by sides of the ravines. They are distributed between 900-

4200 metres. The representatives of both these genera can be separated apart from soral characters, on the basis of structure of scale (cf. Bir, 1962). The scales are prominently toothed and black-edged, the marginal cells having thickened walls than the rest in *Diplazium*, whereas in *Athyrium*, these are almost smoothed-edged, the marginal cells being never thickened.

CYSTOPTERIS Bernhardi

Members small, terrestrial ferns with shortly creeping, paleaceous rhizome and naked, ebeneous stipes; lamina thin, compound pinnate, often glabrous; veins free; sori dorsal on veins, receptacle hardly raised; indusium attached at the base of the receptacle on basiscopic side only, rest free, thin; spores bilateral, reniform or plano-convex.

Only one species, *C. fragilis* is recorded from the area by Hope (1921).

1. **Cystopteris fragilis*** (L.) Bernh., Schard. Neues. Jour. Bot. 1:26, t. 2, f. 9, 1806; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1:450, 1880; Bedd. Handb. Ferns Brit. India 70, 1883; Stewart in Bull. Torrey Bot. Cl. 72: 404, 1945. *Polypodium fragilis* L. Spec. Plant. 1091. 1753.

Rhizome shortly creeping, apex with brown, lanceolate, upto 5 × 1.5 mm scales; stipes 10-20 cm long, naked, fragile and ebeneous; lamina 6-20 × 4-10 cm, ovate-lanceolate, bipinnate to tripinnatifid; pinnae ovate-lanceolate to deltoid with oblong-rhomboidal pinnules; segments with acute apices; veins directed into the teeth; primary and secondary rachises are sparsely covered with uni- or multicellular, glandular hairs; sori globose, 1-4 to a segment; indusium small, membranaceous; spores bilateral, dark-brown, rugose-verrucose, ca. 55 × 37μ (Figs. 1-3).

This is a small, polymorphic species of high-levels, generally growing in rock crevices above 3000 m altitude.

DRYOATHYRIUM Ching

Rhizome large with persistent leaf-bases; stipes covered with entire, lanceolate scales; lamina bipinnate to tripinnatifid with pinnae and pinnules deeply pinnatifid and winged; primary and secondary rachises slightly grooved but the grooves not open at the junction of branches, covered all over with lax, septate, non glandular hairs; veins free, 1- or 2- or 3-forked, or often simple; sori rounded and indusiate.

Only one representative, *D. boryanum* is met within the area which has often been afflicted with names under several genera such as *Polypodium subtripinnatum* (Clarke, 1880), *Phegopteris kingii* (Beddome, 1892), *Dryopteris boryana* (Christensen, 1905-1906), *Athyrium boryanum* (Tagawa, 1935), *Ctenitis boryana* (Copeland, 1947), *Cornopteris boryana* (Tardieu-Blot, 1958), and *Parathyrium boryanum* (Holtum, 1958). The taxonomic status of this fern has been discussed in detail by Bir (1962).

2. **Dryoathyrium boryanum** (Willd.) Ching in Bull. Fan Mem. Inst. Biol. 11:81, 1941; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15:145, 1964. *Aspidium boryanum* Willd. Spec. Plant. 5:285, 1810. *Nephrodium boryanum* Hook. 1862; Blanford in Jour. Asiat. Soc. Bengal 57:311, 1888.

Rhizome ascending, apex clothed with dull-brown, upto 15 × 2 mm scales; stipes upto 1 metre long, more or less scaly and hairy throughout; lamina deeply tripinnatifid, pinnae numerous, stalked, ascending, basal ones the largest, upto 43 × 17 cm; pinnules upto 8 × 3 cm, shortly stalked; lax, septate, pluricellular hairs present on primary and secondary rachises, costae and costules of the segments; sori rounded, in single row on each side of the midrib; indusium small with lacerated margin, fugacious at an early stage; spores dark-brown, perisporiate, covered with thick blunt papillae, 22-66 × 17-41μ (Figs. 4-6).

This is a variable fern as far as size, cutting, and spacing of pinnules is concerned. It is quite rare and is met with near Kotgarh (2,400 m), growing in shade. Blanford (op. cit.) reported it to be not uncommon in well-shaded ravines below 1,800 m altitude.

ATHYRIUM Roth

Rhizome ascending or creeping; stipes thin, fragile, or thick, variable in size, usually naked because of deciduous scales; lamina simple to compound, variable in size and texture, usually glabrous except for members of *A. nigripes* group where prominent setae are present along costae on the upper surface; sori always on acroscopic side of the veinlet, linear-oblong, at least some hippocrepiform or J-shaped; indusium of same shape as sorus and often with fringed margin; spores bilateral, with or without perispore, reniform to plano- or concavo-convex or ellipsoidal, oval or ovoid in pollar view.

KEY TO SPECIES OF *ATHYRIUM*

A. Fronds pinnate
  B. Rhizome ascending, stipes tufted
    C. Lamina small, lanceolate, about 15 × 5 cm, not attenuated downwards, stipe thin and fragile, spores perisporiate ... *A. anisopterum*

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*There is great morphological variation in this species, like the typical European specimens, some Himalayan individuals show tuberculate spores.

C. Lamina small, linear-lanceolate, about 35×8 cm, attenuated downwards, spores non-perisporiate ...	*A. attenuatum*
C. Lamina large, lanceolate, about 80×15 cm or more, clothed with pluricellular hairs all over, lower pinnae reduced to auricles, spores broadly perisporiate ...	*A. thelypteroides*
C. Lamina medium-sized, linear-lanceolate, 20-35×6-8 cm; hairs absent; pinnae oblong-lanceolate, lower 1-2 pair deflexed downwards; spores perisporiate	*A. rupicola*
B. Rhizome widely creeping, stipes distantly placed	
C. Lamina large, lanceolate to subdeltoid, pluricellular hairs present along the costa and costules; few sori 'diplazioid'; spores tuberculated ...	*A. japonicum*
A. Fronds bipinnate	
B. Rhizome widely creeping; lamina large, broadly lanceolate and pinnule distant; spores perisporiate	*A. schimperi*
B. Rhizome ascending or suberect, spores non perisporiate	
C. Prominent setae present along secondary rachis and costae	
D. Stipes long; lamina lanceolate, about 20×4 cm narrow with herbaceous texture; pinnae about 2.5×¾ cm	*A. nigripes*
D. Lamina broadly lanceolate, 40-50×8-12 cm; pinnae large, about 6×1¾ cm; rooting by vegetative buds ...	*A. clarkei*
D. Lamina large, ovate-lanceolate, 30-40×10-25 cm; pinnae 12-15×2-4 cm with apex acuminate; sori very close to the midrib	*A. setiferum*
C. Setae along midrib absent	
D. Lamina subdeltoid or rhomboidal, 35-55×30-45 cm, primary and secondary rachis naked ...	*A. mackinnoni*
D. Lamina broadly lanceolate, primary and secondary rachis densely clothed with chaffy scales; ultimate segments dentate	*A. dentigerum*
D. Lamina lanceolate, 30-40×10-15 cm; pinnae ovate-lanceolate; segments with acroscopic basal lobe the largest ...	*A. flabellulatum*
A. Fronds often bipinnate, rarely more; rhizome ascending; pinnules having acroscopic basal segment the largest; sori large, prominent, and reniform; spores perisporiate	*A. puncticaule*
A. Fronds decompoundly pinnate	
B. Rhizome widely creeping	
D. Stipes stramineous; pinnae lanceolate, falcate; pinnules narrow; sori minute ...	*A. pectinatum*
D. Stipes brown, scaly; pinnae subdeltoid, primary and secondary pinnules large and broad; sori prominent and large ...	*A. fimbriatum*
B. Rhizome ascending	
D. Lamina large, drooping; stipes pinkish-red when fresh, paleaceous; basal segments of the pinnules free, sori prominent	*A. foliolosum*

3. **Athyrium anisopterum** Christ in Bull. Herb. Boiss. 6:692, 1898; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15:143, 1964. *Asplenium macrocarpum* var. *atkinsonii* Hook. & Bak. Syn. Fil. 489, 1874; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1:489, 1880; Blanford in Jour. Asiat. Soc. Bengal 57: 305, 1888.

Rhizome ascending, apex clothed with light-brown, 3.5 × 1 mm, linear-lanceolate scales; stipes tufted, short, fragile, naked, upto 6 cm long; lamina pinnate, lanceolate, 8-16 × 4-6 cm, membranaceous; pinnae broadly lanceolate to subdeltoid, upto 2.5 × 1 cm, shortly stalked, cut down to ½-¾ the distance to midrib into distinct segments having crenate margin, the basal segment the largest; sori hooked with thin, reniform indusium; spores dark-brown, broadly perisporiate, 41-66 × 35-47 μ (Figs. 7-9).

Extremely common on moist shaded rocks near Chadwick falls (1500 m). This delicate-looking, small-sized fern was previously aggregated into *Athyrium macrocarpum* by Beddome (1883) and Hope (1903). It is very distinct from *A. macrocarpum* which possesses stiffer stipes, more compound lamina, and is of much larger size.

4. **A. attenuatum** (Clarke) Tagawa in Acta Phytotax. et Geobot. 16: 177, 1956; Mehra & Bir in Res. Bull. Panjab Univ. (n. s.) 15:137, 1964. *Asplenium filix-foemina* (L.) Bernh. var. *attenuatum* Clarke in Trans. Linn. Soc. Lond. II, Bot. 1:492, Pl. 59, Fig. 1, 1880. *Athyrium filix-foemina* (L.) Roth var. *attenuata* (Clarke) Bedd. Handb. Ferns Brit. India 169, 1883.

Rhizome ascending, clothed with brown, lanceolate, upto 4 × 1 mm scales; stipes scaly at base, firm, brown, upto 4 cm long; lamina pinnate, much-tapering at both ends, linear-lanceolate, upto 35 × 8 cm long; pinnae patent, very close together, basal pinnae gradually reduced to mere auricles, deeply pinnatifid into oblong, serrated segments (2 × 1.5 mm); rachis brownish, naked; sori small; indusium reniform, membranaceous, curls back at maturity; spores light-yellow, non perisporiate, opaque, 28-47 × 17-28 μ (Figs. 10-12).

It is a very rare fern and was collected only near Huttoo top at an altitude of about 3,100 m.

5. **A. thelypteroides** (Michx.) Desv. Prod. 226, 1827; Bedd., Handb. Ferns Brit. India 164, 1883; Mehra & Bir in Res. Bull. Panjab Univ. (n. s.) 15:144, 1964. *Asplenium thelypteroides* Michx. 1803; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1:488, 1880; Blanford in Jour. Asiat. Soc. Bengal

57: 305, 1888. *Athyrium acrostichoides* (Sw.) Diels* 1899; C. Chr. Index Fil. 139, 1905; Stewart in Bull. Torrey Bot. Cl. 72: 414, 1945. *Lunathyrium acrostichoides* (Sw.) Ching in Acta Phytotax. Sinica 9: 71, 1964.

Rhizome ascending, large; stipes upto 30 cm long, scaly throughout; scales broadly lanceolate, brown, upto 12 × 3 mm; lamina upto 50-110 × 15-25 cm, broadly lanceolate, pinnate, gradually narrowed towards the base, clothed all over with pluricellular, uniseriate hairs; pinnae numerous, spreading, upto 15 × 2 cm, basal ones occasionally deflexed downwards and few reduced to auricles, cut down into falcate, segments with obtuse apex and crenated margin; veins often simple; sori in two rows close to the midvein, elongated, J-shaped, lunate, and few often hippocrepiform or even reniform at maturity; indusium persistent at maturity; spores light or dark-brown, perisporiate, perispore broad and with several surface anastomosing folds, 34-50 × 28-41 μ (Figs. 13-15).

Common in moist situations along road-sides near Narkanda (2400 m). Also met with on the hill at the back of Dak Bungalow, upto 2850 m.

6. **A. rupicola** (Hope) C. Chr. Index Fil. 145, 1905; Mehra & Bir in Res. Bull. Panjab Univ. (n. s.) 15: 137, 1964. *Asplenium rupicola* Hope in Jour. Bombay nat. Hist. Soc. 12: 531, t. 5, 1899. *A. filix-foemina* Bernh. var. *retusa* Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 492, 1880 (pro parte).

Rhizome ascending, apex clothed with brown, linear, upto 8 × 1 mm scales; stipes short, densely tufted, bases persistent, straw-coloured, clothed below with dark-brown, linear, hair-pointed, deciduous scales; lamina pinnate, narrow-acuminate at apex, lanceolate, upto 40 × 10 cm, naked except for few fibrillae on main rachis; pinnae about 20 pairs except for pinnatifid apex, subsessile or decurrent on rachis, becoming distant and shorter towards base, horizontal, broadest at base, about 5 × 1.5 cm (anterior lowest segment the largest), cut down into elongated, broad, 8 × 3 mm segments with crenate or spinulosely toothed margin; texture herbaceous to sub-coriaceous; veins usually 1-forked or simple, pinnate in the segment, distinct on lower surface, one veinlet to each tooth; sori linear, curved or J-shaped; indusium curls back at maturity; spores dark-brown, perisporiate with broad and folded wing, 38-52 × 27-41 μ (Figs. 16-18).

It is extremely common along roadsides around Phagu, Theog, ridge near Mattiana, Narkanda, Shali, Chharabra (2400 m), and *en route* Huttoo Peak between 2,100-3,000 m. Beddome (1892, Supplm. p. 35) mentioned *A. rupicola* Edgw. as synonym of *A. filix-foemina* (L.) Roth var. *retusa* Clarke. It may be mentioned that Hope (1899) adopted Edgeworth's name when he described it as a new species. The chief characteristic of this fern is that it grows in the crevices of dry exposed rocks and late in the season can be found only the rhizome with large number of bases of stipes and few drooping fronds. Further, this fern is very gradually narrowed towards base and it hardly possesses bipinnate lamina. Blanford (1888, p. 306) seems to have listed this fern as *A. filix-foemina* var. *retusa* Decne. Sub var. *elongata* Clarke because it is the only *Athyrium* species abundant in rock crevices on roadsides in the localities (Theog and Mattiana, 2,400 m) mentioned by him. Also it exhibits the same characters.

7. **A. japonicum** (Thunb.) Copel. in Phil. Jour. Sci. Bot. 3C: 290, 1908; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 144, 1964. *Asplenium japonicum* (Thunb.) Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 498, 1880 (excl. var. *chattagrammica*); Blanford in Jour. Asiat. Soc. Bengal 57: 307, 1888. *Diplazium japonicum* (Thunb.) Bedd. 1876 & Handb. Ferns Brit. India 180, 1883 (pro parte).

Rhizome widely creeping, sparsely covered with pale or dark-brown, lanceolate, upto 6 × 2 mm scales; stipes distantly placed, variable in size, upto 27 cm long, often longer than the lamina, scaly at base, thin; lamina covered all over with pluricellular hairs, herbaceous, of variable outline and size, broadly lanceolate to sub-deltoid, 15-30 × 5-15 cm, pinnate; pinnae subsessile, lanceolate, upto 8 × 2 cm, cut down upto ¾th the way into broad, falcate 8 × 5 mm segments with obtuse apex and crenated margin; veins simple or rarely forked; rachis hairy and greenish; sori elongated, basal one often double, few may be hippocrepiform; indusium thin, membranaceous, present at maturity; spores light-yellow to brown, prominently tuberculated, 42-57 × 34-42 μ (Figs. 19-21).

It is locally common on forest floor in damp, shaded situations near Chadwick falls (1500 m). In similar situations elsewhere, it was never seen, apparently a rare fern. Very often it has been placed under genus *Diplazium* by several workers on Indian ferns (cf. Beddome, 1883; Stewart, 1942, 1957) because of the occasional presence of double sori but now on basis of cytomorphological evidence (cf. Bir 1961) it has been shown that this is an *Athyrium* species, occupying a border line position between *Athyrium* and *Diplazium*. Recently Ching (1964) separated this fern from *Eu-athyrium* group and considered it a type of his new genus *Athyriopsis*. Earlier, Kurata (1961) had placed it under *Lunathyrium* Koidzumi.

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*This is an illegitimate name (cf. Mehra & Bir, 1960).

8. **A. schimperi** Moug. ex Fée, Mem. Fougères 5: 187, 1850-52; Bedd. Handb. Ferns Brit. India Supplm. 36, 1892; Mehra & Bir in Res. Bull. Panjab Univ. (n. s.) 15: 141, 1964. *Asplenium schimperi* A. Br. 1867; Blanford in Jour. Asiat. Soc. Bengal 57: 305, 1888. *A. filix-foemina* var. *polyspora* Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 493, t. 61, fig. 1. 1880.

Rhizome widely creeping; scales linear-lanceolate, upto 11 × 2 mm, dark-brown; stipes firm, erect, scaly below, upto 30 cm long; lamina oblong-lanceolate to quite deltoid, 25-40 × 10-20 cm, bipinnate; pinnae lanceolate, acuminate, upto 15 × 4 cm with sessile upto 2 × 1 cm pinnules having decurrent base, and placed horizontally on either side of the rachis; texture herbaceous; veins simple or forked; sori typically athyrioid with broad indusium; spores dark-brown with wide, translucent, anastomosing perispore wing having many folds, 38-54 × 28-29 μ (Figs. 22-24).

It is one of the commonest and most abundant of Simla ferns between 1200-2700 m altitude and covers forest floor on Jakhoo and Mashobra hills. Also met with near Chhota Simla (1,800 m), *en route* Shali (2750 m), and near Huttoo Peak (2700 m). It is easily recognized from other *Athyria* by (i) widely creeping rhizome, (ii) large horse-shoe shaped, fimbriate indusia, and (iii) basal portion of the stipe being of deep purple colour when fresh.

9. **A. nigripes** (Bl.) Moore, Index Fil. XLIX, 1857, 98, 1858; Mehra & Bir in Res. Bull. Panjab Univ. (n. s.) 15: 141, 1964. *Asplenium nigripes* Bl. 1860; Hope in Jour. Bombay nat. Hist. Soc. 14: 119, 1903. *Athyrium solenopteris* Bedd. Handb. Ferns Brit. India 166, 1883 (pro parte).

Rhizome ascending; stipes upto 25 cm long, fragile, stramineous at base, usually longer than lamina which is linear, bipinnate, upto 20 × 4.5 cm and herbaceous; pinnae distantly situated, upto 2.5 × 1 cm, deeply pinnatifid to winged rachis; pinnules small, acroscopic basal one the largest, apex obtuse, margin crenated; veins simple; setae present on upper surface along costae and costules; sori linear, oblong, only slightly curved; indusium persistent, spores light or yellowish brown, non-perisporiate, 31-50 × 17-28 μ (Figs. 25-27).

It is an extremely rare fern met with at high levels (Huttoo Peak, 2700 m). The presence of fragile stipes often (longer than the lamina), lower pinnae never shortened, and the presence of setae on the upper surface of lamina, help to distinguish it easily from other species.

10. **A. clarkei** Bedd. Ferns Brit. India Supplm. 11, t. 360, 1876; C. Chr. Index Fil. Supplm. III. 40, 1934. *Athyrium tenuifrons* Moore, Index Fil. 43, 188, 1857. *A. nigripes* var. *B. clarkei* Bedd. Handb. Ferns Brit. India 166, 1883. *A. nigripes* var. *tenuifrons* Bedd. Handb. Ferns Brit. India Supplm. 33, 1892. *Asplenium tenuifrons* Wall. 1828; Blanford in Jour. Asiat. Soc. Bengal 57: 306, 1888; Hope in Jour. Bombay nat. Hist. Soc. 14: 120, t. 22, 1903. *A. clarkei* Atk. Ms.; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 489, 1880.

Rhizome ascending, apex clothed with dark-brown, upto 5 × 1.5 mm scales; stipes tufted, scaly below, upto 20 cm long; lamina 20-50 × 10-20 cm, ovate-lanceolate to acute-lanceolate, bipinnate; pinnae deltoid-lanceolate, upto 10 × 3 cm; pinnules shortly stalked, acroscopic-basal one the largest, upto 2 × 1 cm deltoid, cut down ½ the way to midrib into narrow lobes with serrated apex; conspicuous setae present along costae and costules on upper surface; veins forked; primary rachis stramineous, secondary winged; sori usually in two rows along midvein, short and oblong with fugacious indusium at maturity; spores light-yellow to pale-brown, ovoid to reniform, non-perisporiate, 38-48 × 24-35 μ (Figs. 28-30).

It is often met with on moist rocks in well-shaded ravines or growing in the beds of streams below 2100 m. Also found near Chadwick falls (1500 m). The present fern is closely similar to *A. schimperi* in the outline of lamina but can be distinguished by (i) ascending or suberect rhizome and (ii) non-perisporiate spores. Further, it is characterized by the frequent presence of vegetative buds at the base of the pinnae or towards the apex of the frond. The lamina in fresh state is bright-green in colour. The presence of setae on the upper surface of lamina probably led Beddome (1883, 1892) to place *A. clarkei* under *A. nigripes*, otherwise there is no similarity in these ferns and the size and shape of lamina is much too different.

11. **A. setiferum** C. Chr. Index Fil. 146, 1905 & Supplm. 3: 44, 1934; Mehra & Bir in Res. Bull. Punjab Univ. (n.s.) 15: 142, 1964. *Asplenium nigripes* Mett. var. *dissecta* Moore, Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 491, 1880. *Athyrium nigripes* Bedd. Handb. Ferns Brit. India 166, 1883 (pro parte).

Rhizome ascending, thick; stipes upto 35 cm long, or more (almost nearing the lamina), firm, scaly at base; scales dark-brown, lanceolate, upto 8 × 2 mm; lamina bipinnate, upto 50 × 25 cm, ovate-lanceolate with acute apex; pinnae stalked, lanceolate with caudate apex, upto 15 × 2.5 cm; pinnules stalked, distantly placed, about 1 × 0.5 cm, cut down deeply into toothed segments, stiff setae present on upper side along midrib; veins forked; sori linear-oblong, into two rows, very near the midrib; indusium fugacious at maturity; spores light-brown, non-perisporiate, reniform to plano-convex, 27-38 × 17-24μ (Figs. 31-33).

Often met with on moist rocks near Chadwick falls (1,500 m). The chief distinguishing characters are (i) the presence of sori very close to the midrib, and (ii) the upper surface of lamina being furnished with long weak setae springing from sides of the secondary rachis, costa of the pinnule, and also from veins.

12. **A. mackinnoni** (Hope) C. Chr. Index Fil. 143, 1905; Stewart in Bull. Torrey Bot. Cl. 72: 414, 1945 & Biologia 3: 146, 1957. *Asplenium mackinnoni* Hope in Jour. Bot. 34: 124, 1896 & Jour. Bombay nat. Hist. Soc. 14: 122. t. 23, 1903. *Athyrium nigripes* Bedd. Handb. Ferns Brit. India 166, 1883 (pro parte).

Rhizome thick, ascending or somewhat suberect, clothed with bright castaneous-brown, broadly linear, upto 17 × 2 mm scales; stipes densely tufted, firm, upto 35 cm long, scaly below and pale or straw-coloured above; lamina bipinnate, broadly lanceolate, or sub-deltoid, upto 50 × 30 cm; pinnae stalked upto 17 × 4 cm, sub-basal the largest, ascending, lanceolate, with sessile, 2 × 1 cm; pinnules sessile with decurrent base, slightly auricled on superior side, cut down 2/3rd to costa into broad, falcate, distant, serrated (with 2 or more teeth) segments, of which the acroscopic one the largest; texture herbaceous, thin, glabrous; veins forked, pinnate; sori mostly on superior veinlet of each lobe, linear, curved, hippocrepiform with thin large athyrioid indusia, thrown back at maturity; spores yellowish-brown, non-perisporiate, 34-48 × 19-34 μ (Figs. 34-36).

Collected from Simla region by Blanford, Hope, Collet (Huttoo, 2,700 m) and Bliss, 2,460 m and upwards (cf. Hope, 1903). This large, broad-spreading fern is recognized by: (i) conspicuously large pale stipes, (ii) broadly lanceolate or almost subdeltoid lamina, (iii) sori generally away from costa, curving outside and indusia still more curved, and (iv) the total absence of setae on the secondary rachises and costae. Blanford's (1888) *Asplenium* (*Athyrium*) *nigripes* Mett., in greater part at least, is *A. mackinnoni* (cf. Hope, 1903) and according to him it is common on the Northern face of Kumalhori and Huttoo between 2,400-2,850 m but not nearer Simla.

13. **A. dentigerum** (Clarke) Mehra & Bir in Amer. Fern Jour. 50: 279, 1960; Pichi-Sermolli, Index Fil. Supplm. 4: 34, 1965. *Asplenium filix-foemina* var. *dentigera* C. B. Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 491, 1880; Blanford in Jour. Asiat. Soc. Bengal 57: 306, 1888. *Athyrium filix-foemina* var. *dentigera* Bedd. Handb. Ferns Brit. India 169, 1883.

Rhizome large, ascending, suberect, clothed with ovate-lanceolate, upto 14 × 3 mm, dark-brown scales; stipes firm, densely scaly, upto 20 cm long; lamina 50-70 × 15-25 cm, broadly lanceolate, bipinnate; pinnae subsessile, upto 15 × 3 cm with acuminate apex; pinnules sessile upto 11 × 4 mm; cut down about the midrib into segments with dentate margin; rachis minutely scaly, brown, succulent, appearing grooved when dry; veins simple or forked; sori linear or curved, or more frequently globose, present in two prominent rows along costa of pinnules and almost covering these; indusium subquadrate or horse-shoe shaped, almost totally fugacious at maturity; spores yellowish-brown, non-perisporiate, but with thick exine, usually reniform, or sometimes planoconvex, 31-45 × 17-28 μ (Figs. 37-39).

It is common on Northern face of Huttoo Peak between 2,700-3,000 m on forest floor, growing in circular tufts and often attaining a height of about 90 cm. In cutting, *A. dentigerum* is quite near typical *A. filix-foemina* but the indusia are smaller and less persistent, pinnules are equal sided, with cutting almost to the costa, and the segments are prominently dentate.

14. **A. flabellulatum** (Clarke) Tard.-Blot, Aspl. du Tonkin 81, t. 12, 1932; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 138, 1964. *Asplenium filix-foemina* Bernh. var. *flabellulata* Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 493, Pl. 60, 1880.

Rhizome ascending, short; scales dark-brown, lanceolate, upto 4-1½ mm; stipes, upto 12 cm long, scaly below, naked upwards; lamina, upto 35 × 10 cm, lanceolate, bipinnate; pinnae numerous, horizontal, upto 6 × 2 cm, apex acuminate, lower pairs reduced; pinnules sessile, with decurrent base, oblong-lanceolate, with lower base cuneate, upto 10 × 6 mm; margin cut down into flabellately incised segments with obtuse apex; veins forked; sori hooked, globose; indusium small, fugacious at maturity; spores light-yellowish, or brown, non-perisporiate, 38-49 × 24-32 μ (Figs. 40-41).

It is a medium-sized rare fern. Only few specimens were seen on forest floor *en route* Huttoo Peak (2,700 m). The fern belongs to *A. filix-foemina* complex but can be separated by (i) lamina being dark-green when fresh but of brownish colour on drying, (ii) often deflexed lower pinnae, and (iii) laciniately serrated pinnules.

15. **A. puncticaule** (Bl.) Moore, Index Fil. 186, 1860; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 143, 1964; Bir in Jour. Indian Bot. Soc. 43: 568-569, 1964. *A. macrocarpum* (Bl.) Bedd. 1863 & Handb. Ferns Brit. India 165, 1883. *Asplenium macrocarpum* Bl. 1857; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 488, 1880.

Rhizome ascending; scales light-brown, lanceolate, upto 7 × 2 mm with smooth or slightly dentate margin but unlike *Diplazium*; stipes scaly, erect, stout, brownish, upto 10-45 cm long; lamina 15-40 × 5-25 cm, lanceolate, bipinnate; pinnae variable in size and cuttings, 3-12 × 1.5-3 cm with pinnules deeply pinnatifid, basal pinnule upto 2 × 0.6 cm; texture herbaceous; veins simple or rarely forked; sori medial on the veins, reniform with conspicuous indusium; spores yellowish to dark-brown, perisporiate, perispore broad, loose, forming irregular folds or ridges and wrinkles on the surface, 36-53 × 27-38μ (Figs. 42-44).

Often met with on shaded rocks especially near Chadwick falls (1,500 m). This is a variable fern, both in size and cutting. Pinnate and compoundly divided fronds are met with. It is recognized by (i) pinnae of simple forms with auricle at base and margin cut down to half the way, (ii) the pinnules of compound forms are obliquely cut on basiscopic side, and (iii) large prominent sori, often with reniform indusia like *Dryopteris*. According to Bir (1964) the earlier and most widely used name, *A. macrocarpum* (*macrocarpon*) (Bl.) Bedd., is illegitimate.

16. **A. pectinatum** (Wall.) Presl, Tent. Pterid. 98, 1836; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 141, 1964. *Asplenium pectinatum* Wall. 1828; Blanford in Jour. Asiat. Soc. Bengal 57: 307, 1888. *Asplenium filix-foemina* Bernh. var. 2 *pectinata* Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 492, Pl. 58, 1880. *Athyrium filix-foemina* (L.) Roth var. *pectinata* (Wall.) Bedd. Handb. Ferns Brit. India 169, 1883.

Rhizome widely creeping and branched; scales brown, lanceolate, upto 7 × 1.5 mm; stipes fragile, straw-coloured, 10-35 cm long; lamina upto 30-60 × 8-36 cm; variable, broadly lanceolate to subdeltoid with acuminate apex, decompoundly pinnate and finely dissected; pinnae stalked, distantly placed, 6-15 × 2-4.5 cm, ascending with slender, naked, greenish, rachis; pinnules, upto 15 × 6 mm, subdeltoid, cut down into 6 × 3 mm ultimate oblong narrow segments with dentate margin, secondary rachises minutely pubescent; veins forked; sori minute; indusium thin, membranaceous; spores dark-brown, perisporiate, perispore broad with wrinkles and anastomosis on the surface, 27-38 × 21-33 μ (Figs. 45-47).

It flourishes in rather moist situations or on partially shaded forest floor, or along road sides between 1,200-2,100 m, common all around Tara Devi (1,800 m), near Katnol (2,100 m), Tutikandi (1,800 m), Chhota Simla (1,800 m). It is the most delicate and brittle of Simla ferns with very minute sori, and stipes of variable length.

17. **A. fimbriatum** (Wall.) Moore, Index Fil. 185, 1860; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 144, 1964. *Asplenium atkinsonii* var. *andersonii* Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 487, t. 57, 1880; Blanford in Jour. Asiat. Soc. Bengal 57: 305, 1888. *A. fimbriatum* Bedd. Handb. Ferns Brit. India Supplm. 37, 1892.

Rhizome widely creeping, apex clothed with lanceolate, upto 9 × 2.5 mm scales; stipes solitary, distant, stout, brownish, paleaceous, upto 25 cm long; lamina, upto 38 × 35 cm, subdeltoid, acuminate, tripinnate or quadripinnatifid; pinnae stalked, deltoid-acuminate, upto 15 × 5 cm; primary pinnules stalked, subdeltoid, upto 5 × 2.5 cm, secondary pinnules sessile, upto 15 × 8 mm, cut down about midrib into rounded segments; veins forked; rachis pale-brown, more or less flexuose; sori small, reniform with crescent-shaped, fimbriate indusia; spores light or dark-brown, perisporiate, perispore medium to broad, loose and reticulately folded, 31-53 × 21-34μ (Figs. 48-50).

Often grows in abundance on forest floor at high altitudes between 2,400-3,000 m (Huttoo Peak, 3,000 m). Clarke (1880, p. 495) and Beddome (1883, p. 172) described the next species, *A. foliolosum* as variety of the present one but the two differ markedly in the nature of rhizome (which is creeping in *A. fimbriatum* and ascending or suberect in *A. foliolosum*) and also in the size and shape of sori. As compared to the Western Himalayan samples, *A. fimbriatum* of the Eastern region possesses often large fronds, over a metre in length with primary pinnae 25-50 × 15-35 cm.

18. **A. foliolosum** (Wall.) Moore ex Sim, Priced. Cat. 6, 22, 1859; Bedd. Handb. Ferns Brit. India Supplm. 37, 1892; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 144, 1964.

Rhizome ascending or suberect; scales lanceolate, upto 12 × 3 mm, brown; stipes and rachis scaly throughout, deep pink in colour when fresh, firm, upto 32 cm long; rachis with gland at the base of the pinnae; lamina large, 40-60 × 20-30 cm, often drooping, tri- or quadripinnatifid, ovate-lanceolate; pinnae upto 20 × 4 cm, with numerous pairs of stalked, ascending, upto 3 × 1.5 cm, subdeltoid pinnules bearing large secondary pinnules, of which the basal acroscopic one the largest, upto 7 × 4 mm and cut down into minute segments; veins forked; sori J-shaped or reniform, prominent, with conspicuous indusium; spores dark or light-brown, broadly perisporiate with loose wing forming anastomosing folds, 41-64 × 28-45 μ (Figs. 51-53).

It is an high altitude fern frequently found near Huttoo Peak (3,000 m). This species is nearer *A. puncticaule* rather than *A. fimbriatum* as previously thought but possesses much smaller sori as compared to *A. puncticaule*. The most characteristic feature of this fern is that the lowest secondary pinnule on the superior side of pinnae is always the largest and often double the size of others and also the lowest superior lobe of the pinnule is elongated.

DIPLAZIUM Swartz.

Rhizome stout in many species, ascending or creeping; stipes usually scaly, at least in the lower portion, with conspicuous adaxial groove running throughout their length; scales with thick and irregular, dentate margin; lamina pinnate to tripinnatifid, membranaceous and often glabrous; sori elongated, usually on acro- and basiscopic side of veinlet, seldom short, with membranaceous indusium, which is often fugacious at an early stage; spores broadly perisporiate, bilateral.

Three species are met within the area, of which *D. lobulosum* is small-sized, and the other two large-sized with compound lamina. Blanford's (1888, p. 307, Pl. 16) record of *Asplenium (Diplazium) torrentium* Clarke from the area (either Chadwick falls at 5,800′ or Samali Nala at 4,500′, Blanford) may possibly pertain to simpler form of *D. polypodioides* which is a very variable fern as to the size, cutting of pinnules, and length of sori—depending mainly on the habitat. The Sikkimese samples of *D. torrentium* are large-sized, compoundly pinnate with pinnules cut down almost to the costa into segments which are falcate and more serrate than *D. polypodioides*, sori emerging at distance from midrib, and lowest basiscopic veinlet often twice forked. Throughout Simla region such specimens have not been seen. Further, Blanford (loc. cit.) also enumerated two more ferns, namely *Asplenium (Diplazium) latifolium* Don var. *polymorpha*, Wall. Sp. (p. 307, Pl. 17) and *Asplenium latifolium* var. *frondosa*, Wall. sp. (p. 307, Pl. 18) from Simla region. But according to Christensen (1934), Wallich's *Asplenium polymorphum* and *A. frondosum* are synonymous with *Diplazium giganteum* (Bak.) Ching (= *Diplazium polymorphum* Presl) which is met with frequently in Kulu valley (Manali, 2,100 m).

It may be mentioned that specimens falling within the descriptive range of *D. polypodioides* closely resemble the figures of Blanford referred to above Therefore it is surmised that true *Asplenium latifolium* Don [= *D. latifolium* (Don) Moore] of the Eastern Himalayas or *D. polymorphum* Presl may not be found in the area and all the specimens refer to the polymorphic species, *D. polypodioides*.

KEY TO SPECIES OF *DIPLAZIUM*

A. Rhizome ascending or suberect
  B. Fronds simply pinnate ... *D. lobulosum*
  B. Fronds bipinnate or tripinnatifid ... *D. polypodioides*
A. Rhizome widely creeping and fronds tripinnate ... ... *D. spectabile*

19. **Diplazium lobulosum** (Wall.) Presl, Tent. Pterid. 114, 1836; C. Chr. Index Fil. 234, 1905; Mehra, Ferns Muss. 19, 1939. *Asplenium longifolium* Don, 1825; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 478, 1880. Blanford in Jour. Asiat. Soc. Bengal 57: 304, 1888. *Diplazium longifolium* (Don) Moore 1857; Bedd. Handb. Ferns Brit. India 179, t. 87, 1892.

Rhizome ascending; scales dark-brown, linear-lanceolate, upto 5 × 1.5 mm; stipes densely tufted, upto 20 cm long; lamina pinnate, lanceolate, upto 30 × 10 cm; pinnae, upto 20 pairs, stalked, broadly lanceolate, 4-8 × 1-3 cm with acuminate apex and margin, deeply cut down forming acroscopic basal segment or lobe the largest; veins in groups corresponding to segments; sori linear, much elongated, basal ones frequently paired but unequal; indusium thin, membranaceous persistent at maturity; spores dark-brown, perisporiate, wing broad and translucent and folded, 33-52 × 28-41 μ (Figs. 54-56).

Frequently met with on moist rocks by streams in well-shaded ravines between (1,500-2,400 m) especially at Chadwick falls and Glen but no where a common fern. This was erroneously placed under *Euasplenium* by Clarke (1880).

20. **D. polypodioides** Blume, Enum. Pl. Jav. 194, 1828; Bir in Bull. Bot. Surv. India 4: 5, Figs. 16 & 18, 1962; Mehra & Bir in Res. Bull., Panjab Univ. (n.s.) 15: 146, 1964. *Asplenium polypodioides* Mett. 1856; Blanford in Jour. Asiat. Soc. Bengal 57: 307, 1888.

Rhizome stout, ascending (very rarely shortly creeping) apex clothed with brown, linear-lanceolate, upto 17 × 1.5 mm scales; stipes densely tufted, scaly below, naked upwards, stout, straw-coloured, about 60 cm long; lamina of variable size, broadly ovate-lanceolate, bipinnate or tripinnatifid, upto 80 × 60 cm or more, with 8-12 pairs of primary pinnae, of which the subbasal one is the largest, up to 40 × 15 cm; pinnules, upto 10 × 2 cm, cut down into broad, obtuse or acute segments; veins forked; texture herbaceous; sori in two oblique rows, linear; indusium thin, fugacious at an early stage; spores light-brown, perisporiate, perispore narrow and transparent, 27-49 × 21-41 μ (Figs. 57-59).

This large-sized fern is extremely abundant all around, often flourshing between 1,500-2,400 m along water courses. Specimens from different habitats apparently look different but in the absence of dependable characters these cannot be segregated into different form or varieties.

21. **D. spectabile** (Wall. ex Mett.) Bir in Res. Bull. Panjab Univ. (n. s.) 12: 130, 1961; Mehra & Bir in Res. Bull. Panjab Univ. (n. s.) 15: 146, 1964. *Asplenium multicaudatum* Wall. 1828; Clarke in Trans. Linn. Soc. Lond. II, Bot. 1: 502, 1880. *Diplazium umbrosum* var. *multicaudatum* Bedd. Handb. Ferns Brit. India 190. t. 91, 1883.

Rhizome widely creeping, apex clothed with brown scales; stipes distant but often aggregated near apex, straw-coloured, scaly at base, naked upwards; lamina 30-60 × 15-30 cm, tripinnate, ovate, apex acute, broadest at base; pinnae upto 24 × 8 cm, stalked, ascending with acute apex; pinnules, upto 21 pairs, stalked, deeply pinnatifid, oblong, 6 × 1.5 cm; veins forked; sori linear-oblong, or globose at maturity, short, starting from midrib, not reaching to the margin of the segment; indusium not much elongated, thin, curved back at maturity; spores yellow or brown, broadly perisporiate, perispore clear, 22-49 × 21-41 μ (Figs. 60-62).

It is quite common on the forest floor near Chadwick falls, Tutikandi, *en route* Luri or Glen between 900-1,500 m, forming good populations.

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EXPLANATION TO TEXT FIGURES

(Figs. 1-62 on pages 274-277)

PLATE I

Figs. 1-3 : *Cystopteris fragilis* (L.) Bernh.
1. Habit sketch. 2. Pinnule showing venation
and position of sori. 3. Spores.

Figs. 4-6 : *Dryoathyrium boryanum* (Willd.) Ching
4. Two pinnules. 5. Segment enlarged. 6. Spores.

Figs. 7-9 : *Athyrium anisopterum* Christ
7. Frond. 8. Upper pinna. 9. Spores.

Figs. 10-12: *A. attenuatum* (Clarke) Tagawa
10. Frond. 11. Spores. 12. Upper pinna.

Figs. 13-15: *A. thylypteroides* (Michx.) Desv.
13. Two pinnae. 14. Segment. 15. Spores.

Figs. 16-18: *A. rupicola* (Hope) C. Chr.
16. Frond. 17. Segments. 18. Spores.

(Figs. 1,4,7,10,13,16 ×Half natural size; Figs. 2,5,8,12,
14,17 ×5; Figs. 3,6,9,11,15,18 ×380).

PLATE II

Figs. 19-21 : *Athyrium japonicum* (Thbg.) Copel.
19. Middle pinnae. 20. Segment. 21. Spores.

Figs. 22-24: *A. schimperi* Moug.
22. Middle pinnae. 23. Segments. 24. Spores.

Figs. 25-27 : *A. nigripes* (Bl.) Moore
25. Frond. 26. Pinnule. 27. Spores.

Figs. 28-30 : *A. clarkei* Bedd.
28. Middle pinnae. 29. Segments. 30. Spores.

Figs. 31-33 : *A. setiferum* C. Chr.
31. Middle pinnae. 32. Pinnule showing sori
close to the midrib. 33. Spores.

(Figs. 19,22,25,28,31 ×Half natural size ; Figs. 20,23,26,
29,32 ×5 ; Figs. 21,24,27,30,33 ×380).

PLATE III

Figs. 34-36 : *Athyrium mackinnoni* (Hope) C. Chr.
34. Middle pinna. 35. Pinnule. 36. Spores.

Figs. 37-39 : *A. dentigerum* (Clarke) Mehra & Bir
37. Middle pinnae. 38. Segment. 39. Spores.

Figs. 40-41 : *A. flabellulatum* (Clarke) Tard.-Blot.
40. Pinnule. 41. Spores.

Figs. 42-44 : *A. puncticaule* (Bl.) Moore
42. Middle pinnae. 43. Segments. 44. Spores.

Figs. 45-47 : *A. pectinatum* (Wall.) Presl
45. Middle pinnae. 46. Pinnule. 47. Spores.

Figs. 48-50 : *A. fimbriatum* (Wall.) Moore
48. Two pinnules. 49. Segment. 50. Spores.

(Figs. 34,37,42,45,48 ×Half natural size; Figs. 35,38,40,
43,46,49 ×5; Figs. 36,39,41,44,47,50 ×380).

PLATE IV

Figs. 51-53 : *Athyrium foliolosum* (Wall.) Moore ex Sim
51. Pinnae. 52. Segments. 53. Spores.

Figs. 54-56 : *Diplazium lobulosum* (Wall.) Presl
54. Middle portion of the frond. 55. Upper
Pinna. 56. Spores.

Figs. 57-59 : *D. polypodioides* Bl.
57. Middle pinnules. 58. Pinnule near apex
enlarged. 59. Spores.

Figs. 60-62 : *D. spectabile* (Wall. ex Mett.) Bir
60. Lower pinnae. 61. Basal segments.
62. Spores.

(Figs. 51,54,57,60 ×Half natural size ; Figs. 52,55,
58,61 ×5 ; Figs. 53,56,59,62 ×380).

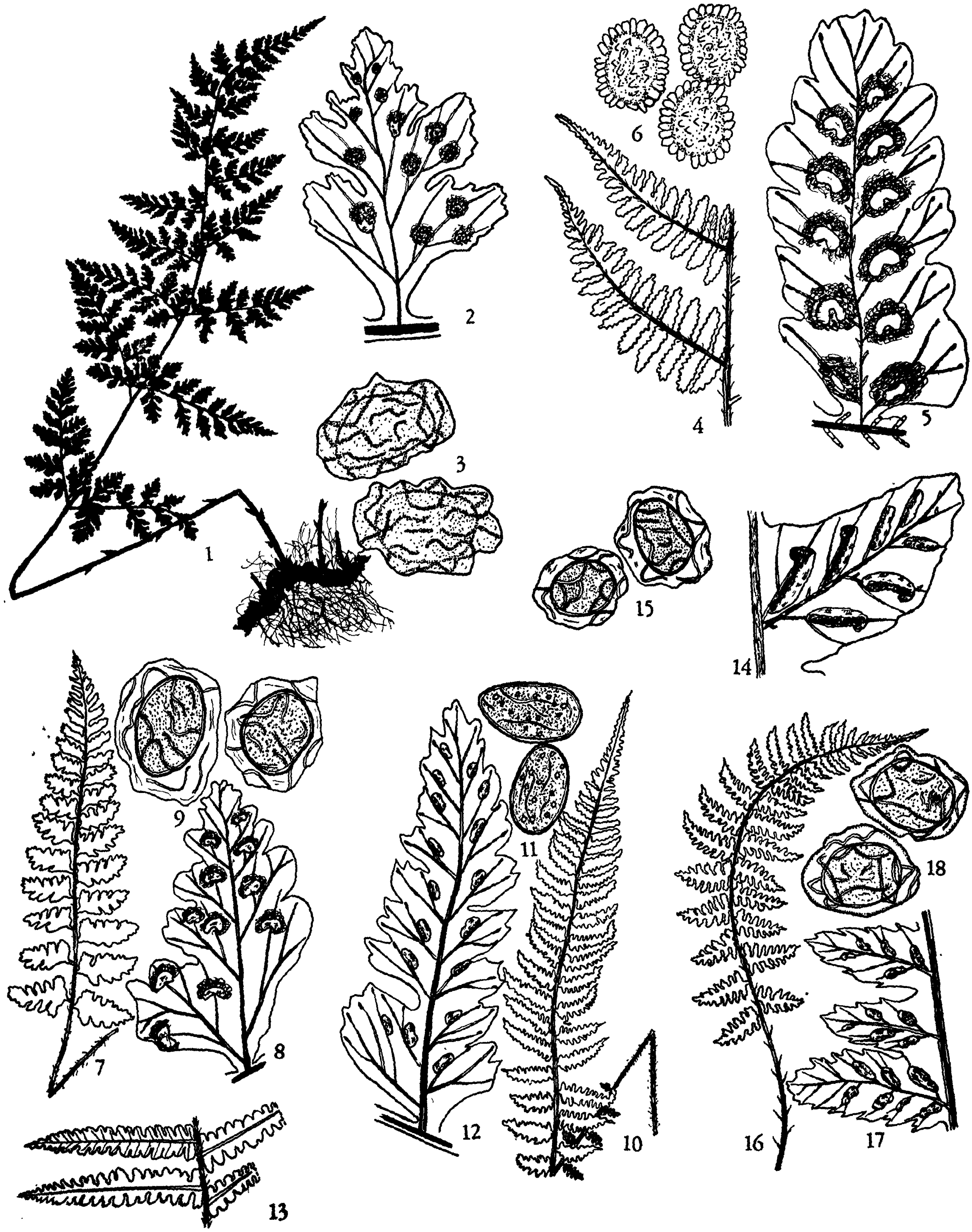
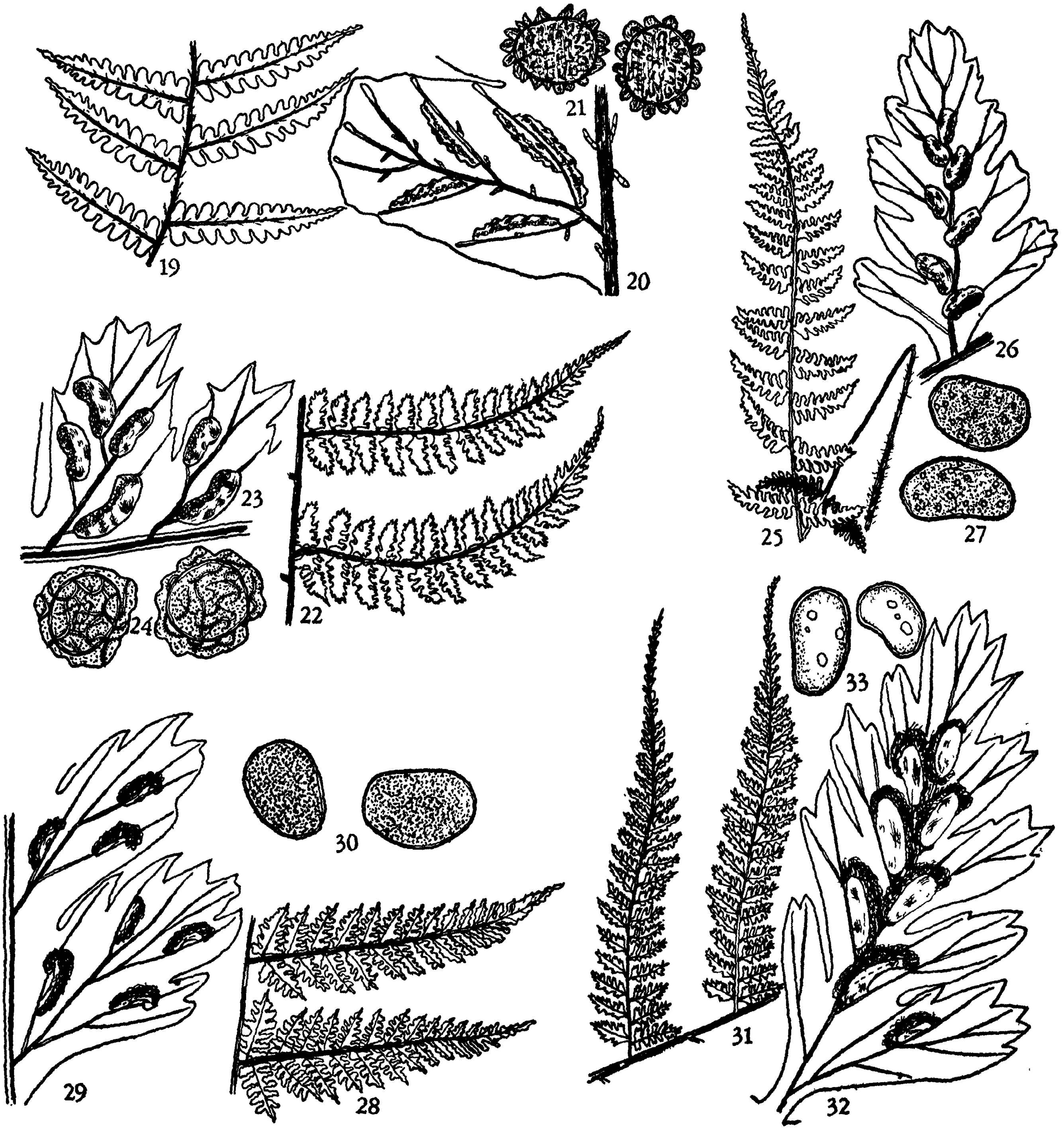


PLATE I



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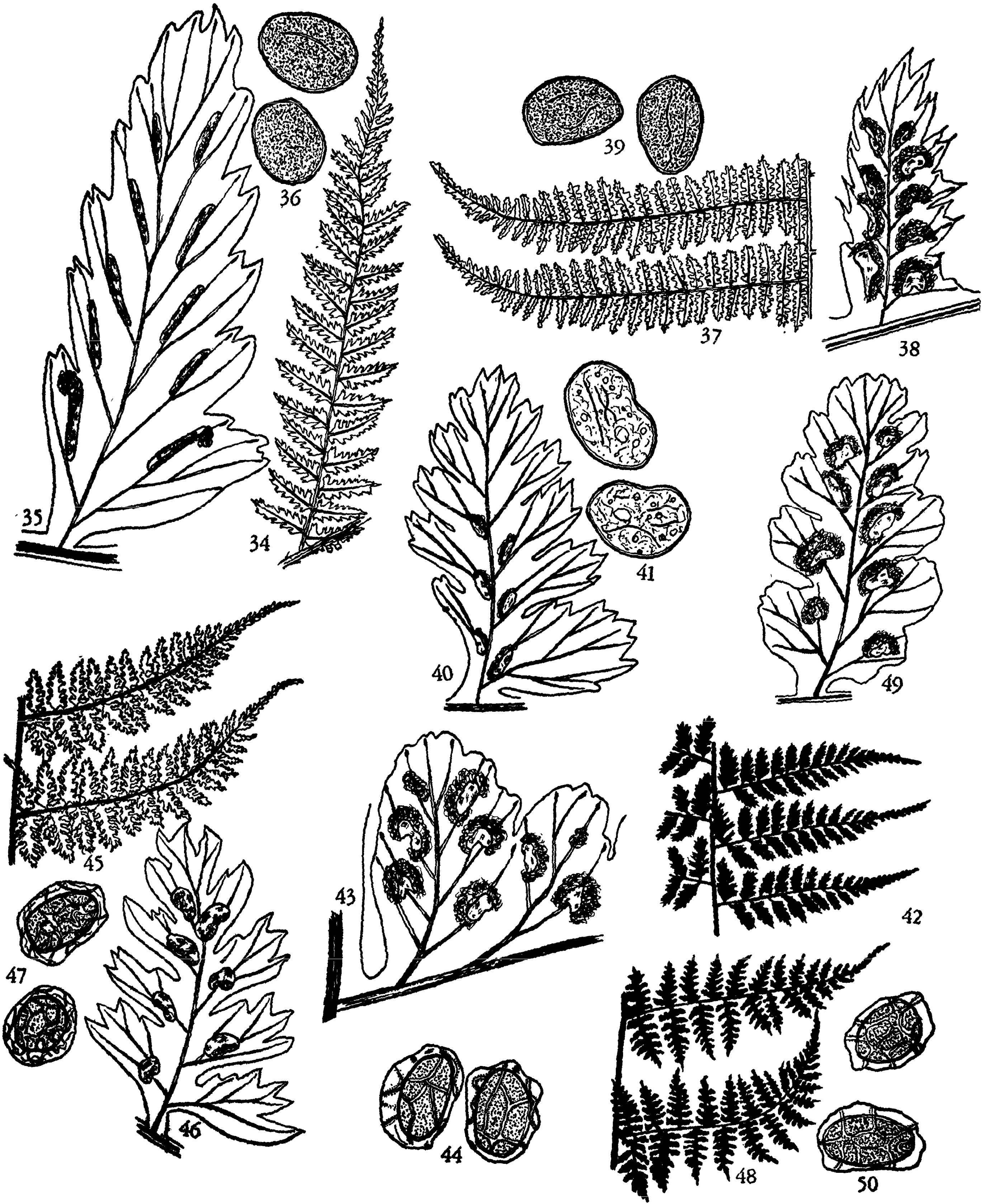

PLATE III

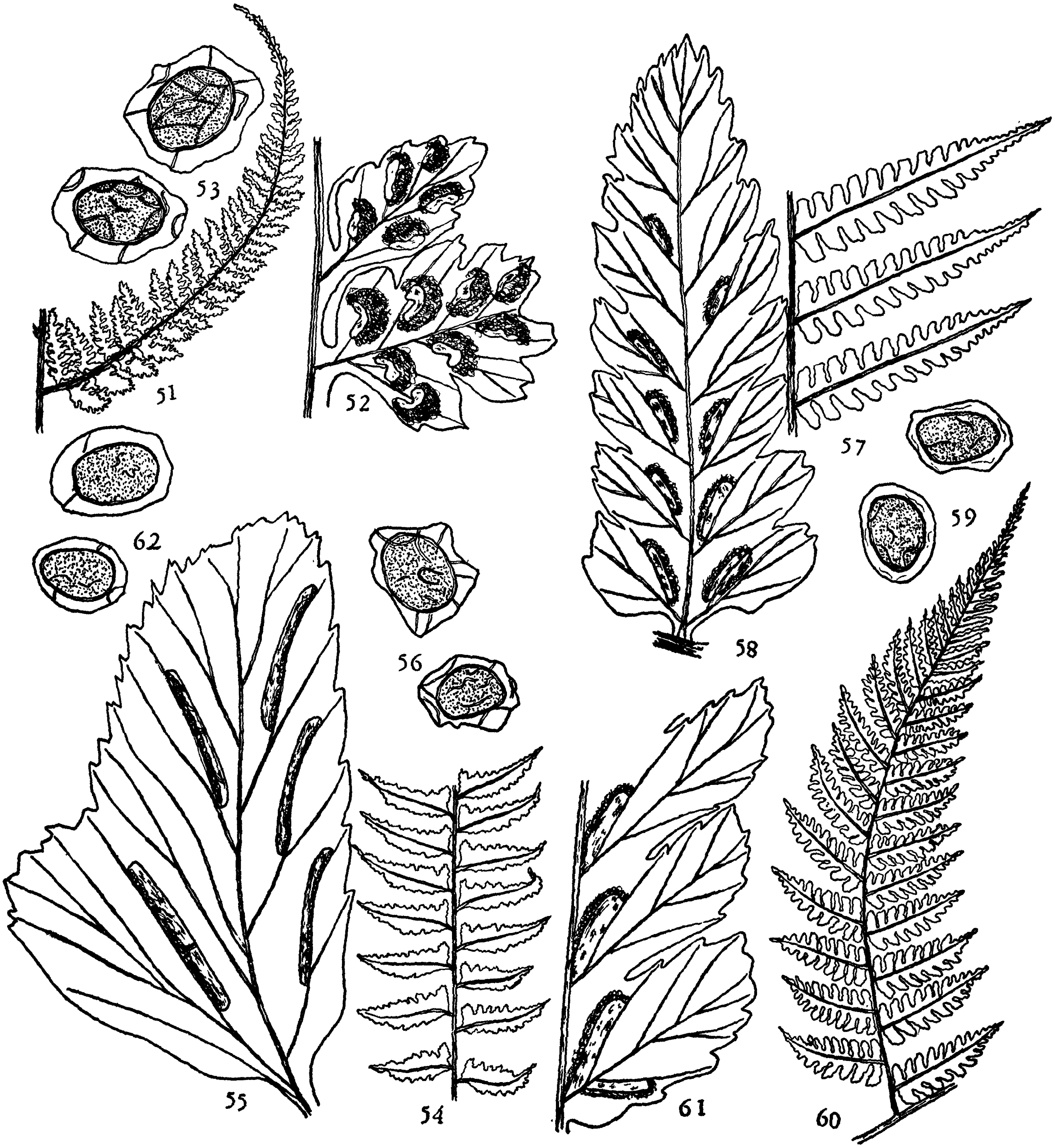

PLATE IV